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# Measles Reporting Completeness During a Community-Wide Epidemic in Inner-City Los Angeles

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## Synopsis .....

*A study was undertaken to determine the extent of measles underreporting among preschool-age children. In two community surveys conducted in inner-city Los Angeles during 1990 and 1991, respondents were asked whether preschool-age children in their households had ever been ill with measles. Information about measles episodes was obtained and*

*medical records were reviewed, when available. A probable measles case was defined as having 3 or more days of rash with fever of 38.3° centigrade or greater, and either cough, coryza, or conjunctivitis.*

*To determine the proportion of cases reported, probable measles cases identified were matched with measles cases reported to the Los Angeles County Department of Health Services. Of the 947 children ages 6 weeks through 59 months included in the surveys, 35 children had experienced an illness episode which met the probable measles case definition. Ten (29 percent) of the 35 probable measles cases were reported to the health department. Hospitals reported 9 (69 percent) of 13 probable measles cases evaluated while private physicians' offices reported 0 (0 percent) of 12 evaluated (Fisher's exact test,  $P < 0.001$ ), although 5 children were seen by private physicians before rash onset.*

*Reporting was more complete for cases occurring during 1990 and 1991 (33 percent) than from 1987 through 1989 (18 percent). The hospitalization rate for preschool-age children with probable measles cases in the catchment area was estimated to be 8 percent (95 percent confidence interval = 0 to 18 percent).*

*Although measles is a serious communicable disease which is almost completely preventable, cases of it among preschool-age children in this high-incidence area were substantially underreported, especially by private physicians. Due to reporting bias, reported measles cases were representative of more severe cases than all the cases that occurred.*

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**R**EPORTING OF COMMUNICABLE DISEASES to local health departments by physicians has been central to communicable disease control programs since the late 19th century (1,2). Without knowledge of disease occurrence, health officials are limited in their ability to identify sources of illness and prevent further disease in the community. Additionally, if the extent of morbidity due to particular diseases is not ascertained accurately, developing meaningful pri-

orities for prevention and a long-term strategy for health services is difficult.

If reported cases of a given disease are not representative of all cases that are occurring, biases are introduced into surveillance data that mislead investigators regarding severity of disease or groups at risk. In California, administrative law requires that 65 communicable diseases be reported to the local health department by any person with knowledge of a

case, and medical, school, and daycare personnel are specifically identified in the law as persons who should report communicable diseases (3).

Although measles has been reportable in California since 1945, it is widely known to be underreported. Because measles vaccine and immune globulin are readily available and are effective in preventing measles or decreasing disease severity in exposed persons, reporting of cases is important to prevent further morbidity and mortality in the community. Previously, after a mail survey of parents following the 1970–71 measles epidemic in St. Louis, researchers estimated that only 15 percent of all measles cases were reported (4), and in a study of measles complication rates in Los Angeles County after the 1977 measles epidemic, it was estimated that only 15 to 20 percent of all measles cases were reported (5).

Using capture-recapture methods, reporting of all persons hospitalized with measles was estimated to be 51 percent in Los Angeles County during 1989 (6). Reporting of measles cases treated at 12 New York City hospitals during 1991 was estimated to be 45 percent (7).

In a measles epidemic occurring in Los Angeles County, CA, from August 1987 through July 1991, more than 6,600 cases of measles were reported to the Los Angeles County Department of Health Services (LACDHS) Immunization Program. Preschool-age children residing in a predominantly Latino inner-city area of Los Angeles were at highest risk during this epidemic. Two community surveys were conducted to determine the completeness of measles reporting among preschoolers residing in this inner-city area.

## Methods

Study A was conducted from May 15 to June 15, 1990, and Study B, from April 15 to May 15, 1991. Both were part of household cluster surveys, modeled after those commonly used by the World Health Organization's Expanded Programme on Immunization (8,9). The surveys were carried out in 53 census tracts in central and south-central Los Angeles, primarily to determine immunization coverage among children ages 6 weeks through 59 months. In these surveys, 50 clusters were selected from the 53 census tracts with probability proportionate to size (PPS).

PPS sampling was conducted by summing the preschool-age populations of the 53 census tracts, dividing the sum by 50 to determine the sampling interval, generating a random start point using a computer, and systematically selecting 50 clusters

using the sampling interval. More than one cluster was selected within several more populous census tracts. A random start point was determined for each cluster by randomly selecting a block and a household on the block. Households were visited consecutively from the start point and all eligible children from seven households in the block were included.

Household inclusion criteria were permanent residence of a child ages 6 weeks through 59 months and the presence of a family member at least 16 years old who was willing to participate in an interview about the child. Based on 1980 census data adjusted for subsequent births and deaths, the 1990 population of children younger than 5 years in this study area was estimated to be 32,149. Study A included 502 children, and Study B included 445 children.

In addition to immunization information, each respondent was asked whether the child had ever been ill with measles. If the response was positive, the respondent was asked about the disease episode believed to be measles, including onset date, symptoms experienced, photo identification of the rash (measles versus chickenpox), and name and address of the medical provider seen, if any. Review of medical records was attempted for children with probable measles who had seen a medical provider. Information collected from medical records included date of visit, illness history, symptoms present, results of laboratory tests performed, and physician's diagnosis. Data from the two studies were combined for this analysis.

A probable measles case was defined as having a generalized rash for 3 or more days, fever of at least 38.3° centigrade or "hot" to the touch, and at least one of the following: cough, coryza, or conjunctivitis. A confirmed measles case was defined as laboratory confirmed or, if not laboratory confirmed, meeting the probable case criteria and being linked epidemiologically to another probable or confirmed case (10). A laboratory confirmed measles case was defined as having a positive anti-measles-IgM titer or a fourfold rise in anti-measles-IgG titers from acute- and convalescent-phase blood specimens taken 10 to 14 days apart. An epidemiologic link was believed to exist if a person with measles had contact with a probable or confirmed case of measles 7 to 18 days prior to rash onset.

During the study period, measles surveillance in Los Angeles County was conducted by the LACDHS Immunization Program. California requires that a diagnosed measles case be reported immediately to the local health officer by anyone with knowledge of

the case. Laboratories were not required to report any measles laboratory test results. The health department initiated investigation within 48 hours of receiving a report. To complement passive reporting, the LACDHS Immunization Program carried out active surveillance by telephoning a sample of hospitals, school districts, preschools, university health centers, and private medical offices weekly to receive reports on cases of rash illnesses seen during the previous week.

All suspected, probable, and confirmed measles cases that occurred and were reported to the LACDHS after January 1, 1987, were maintained in a computerized measles data base. Probable measles cases identified in the community surveys were matched by date of birth and name with cases in the LACDHS measles data base to determine the proportion reported. Also, matching was used to identify cases reported to the LACDHS that were linked epidemiologically to probable cases identified in the community surveys; last name and date of rash onset were used to link family members, and rash date and address were used to link nonfamily household contacts.

## Results

Respondents indicated that 73 (8 percent) of the 947 children included in the two surveys had previously had measles. The respondent interviews revealed that 17 (23 percent) of the 73 children had had chickenpox rather than measles, 13 (18 percent) did not meet the probable case definition, and 6 (8 percent) were ill while residents of Mexico; measles episode information was missing for 2 children (3 percent). One of the 13 children who did not meet the case definition was diagnosed by a physician as having a possible measles case but was not reported to the LACDHS. The remaining 35 children (48 percent) met the probable measles case definition and were ill while residing in Los Angeles County. All 35 children were Latino in ethnicity.

Of the 35 children with probable measles, respondents indicated that 12 (34 percent) visited private physicians' offices, 8 (23 percent) went to public hospitals, 5 (14 percent) visited private hospitals, 3 (9 percent) went to county public health clinics, and 5 (14 percent) did not see any health care provider; provider information was missing for 2 children (6 percent).

Medical records were available to review for 21 (75 percent) of the 28 children with probable cases of measles who reportedly went to a health care provider. Of the 21 medical records, a measles

diagnosis was present in 11 (52 percent): symptoms consistent with measles prodrome and a diagnosis of "possible early measles" were present in 1 (5 percent); symptoms consistent with measles prodrome but a diagnosis of upper respiratory infection without mention of rash or measles were present in 5 (24 percent); a diagnosis of roseola was present in 1 (5 percent); a diagnosis of diaper rash with upper respiratory infection was present in 1 (5 percent); and no illness resembling measles was present in 2 (10 percent).

Of the 12 medical records with a diagnosis of measles or possible measles, serology was documented in 7 (58 percent): anti-measles-IgM titers were positive (greater than 1:80) in 3, and acute-phase anti-measles-IgG titers were negative in 4. No convalescent-phase serological test results were documented. All seven cases with documented serology were reported.

Of the 35 children with probable measles cases, 10 (29 percent) were reported to the LACDHS (see table). Hospitals reported 9 (69 percent) of 13 cases evaluated, while private physicians' offices reported 0 of 12 cases evaluated (risk ratio [RR] = undefined; Fisher's exact test,  $P < 0.001$ ); 5 children were seen by private physicians before rash onset. One child with measles, a preschool-age child who did not see a medical provider but was linked epidemiologically to a school-aged sibling, was reported by a school nurse. Two nonreported children with measles were linked epidemiologically to siblings in the LACDHS data base.

Eight (33 percent) of 24 cases occurring in 1990 and 1991 were reported, while only 2 (18 percent) of 11 cases occurring from 1987 through 1989 were reported (RR = 1.8, 95 percent confidence interval [CI]–0.5, 7.3). Seven (28 percent) of 25 children younger than 24 months were reported, and 3 (30 percent) of 10 children ages 24 through 59 months were reported (RR = 0.9, 95 percent CI–0.3, 2.9).

When greater substantiation of measles was required in addition to meeting the probable measles case definition, more complete reporting was observed. Only 21 cases met the probable measles case definition and either were diagnosed with measles or possible measles by a physician, had medical records available for review which documented symptoms consistent with measles prodrome, or were linked epidemiologically to other probable or confirmed cases; 48 percent of these cases were reported. Only 16 children met the probable measles case definition and either were diagnosed with measles or possible measles by a physician, or they were linked epidemiologically to other probable or confirmed

Number of probable measles cases evaluated by various medical providers, their diagnoses, and percentage reported to the Los Angeles County Department of Health Services

Medical provider	Diagnosis								
	Measles			Not measles			Unknown		
	Number	Number reported	Percent reported	Number	Number reported	Percent reported	Number	Number reported	Percent reported
Private hospital:									
Admitted .....	2	2	100	0	0	0	0	0	0
Seen in emergency room .....	3	1	33	0	0	0	0	0	0
Public hospital (emergency room only).....	6	5	83	1	0	0	1	1	100
Private physician office.....	1	0	0	8	0	0	3	0	0
Public health clinic.....	0	0	0	0	0	0	3	0	0
Not seen by provider.....	...	...	...	...	...	...	5	1	20
Unknown.....	...	...	...	...	...	...	2	0	0
<b>Total.....</b>	<b>12</b>	<b>8</b>	<b>67</b>	<b>9</b>	<b>0</b>	<b>0</b>	<b>14</b>	<b>2</b>	<b>14</b>

cases; 63 percent of these cases were reported.

Only two probable measles cases in Studies A and B were hospitalized. While this reflects a hospitalization rate of 20 percent for the 10 reported cases, only 6 percent of the 35 children with probable measles cases were hospitalized. Of 504 children ages 0–59 months with measles cases who resided in the study area and who were reported to the LACDHS from 1987 through 1991, 179 (36 percent) were hospitalized.

Five probable measles cases (14 percent) identified in the surveys reported receiving measles vaccine at age 12 months or older, but before onset of measles. One case (3 percent) received measles vaccine before age 12 months and before onset of measles.

## Discussion

These community surveys indicate that reported measles cases among preschool-age children residing in this high-incidence study area during the 1987–91 epidemic represented between 29 and 63 percent of all cases occurring within that group. Only 29 percent of the probable cases identified in the two community surveys were reported to the LACDHS Immunization Program for confirmation and followup. Yet, the positive predictive value of the probable measles case definition during an outbreak has been estimated to be only 74 percent (L. Markowitz, MD, Centers for Disease Control and Prevention, written communication, 1992), meaning that a quarter of the probable cases may not have been truly measles. If only 74 percent of the probable measles cases identified in these surveys were truly measles cases, then 10 (38 percent) of 26 measles cases were reported to the LACDHS. At best, the sensitivity of measles reporting was 63 percent if only physician diagnosed

and epidemiologically linked cases were considered cases.

Measles reporting by hospitals was more complete than reporting by private physicians' offices. Within the hospital sector, public hospitals reported more completely than private hospitals, and children with cases admitted to the hospital were reported more often than those evaluated in emergency rooms (see table). Local and State health departments should encourage hospitals to conduct measles surveillance in emergency rooms during community outbreaks, and a sample of emergency rooms should be included in active surveillance. Also, anti-measles-IgM titers should be used more frequently by hospitals and physicians to confirm clinical measles. Mandating reporting of positive anti-measles-IgM titers by laboratories and conducting active surveillance for these results during outbreaks would improve surveillance for cases that have been confirmed serologically.

None of the 12 cases seen in private physicians' offices was reported. If measles epidemics are to be controlled and understood properly, measles reporting by private physicians' offices must improve dramatically. Although physicians documented only prodromal symptoms in five cases, three of nine medical records reviewed in physicians' offices documented rashes; only one case was diagnosed as measles and was not reported.

In addition, one physician diagnosed possible measles in a case which did not meet our probable case definition; the physician failed to report the case to the LACDHS. Although the medical records of many children documented symptoms which were consistent with measles prodrome without rash, the survey respondents gave reasonable accounts of

rashes which were consistent with the natural history of measles. Many children with uncomplicated cases of measles may visit physicians' offices only before rash onset, leading to misdiagnoses by physicians and resultant unreported cases.

Although little can be done to improve surveillance of undiagnosed measles cases, improving reporting of measles cases diagnosed in private physicians' offices can best be accomplished through promotion of reporting by local medical societies. Publicity about the measles epidemic appeared to improve reporting in Los Angeles County, as reporting during the latter years of the outbreak was better than before 1990.

Also, local and State health departments should facilitate physician reporting by assuring that it is simple, easy, and quick. This can be accomplished by establishing special measles reporting hotlines during outbreaks, and dedication of fax machines for reporting purposes only.

The high rate of hospitalization (36 percent) observed for preschool-age children residing in the study area during the 1987-91 epidemic was probably an artifact of more complete reporting of hospitalized cases than nonhospitalized cases. Using the positive predictive value of the case definition and the proportion of measles cases identified in children in this study who were hospitalized, we estimate that the hospitalization rate of preschool-age children with measles in this inner-city area was 8 percent (95 percent CI = 0 to 18 percent) during the 1987-91 epidemic.

Two unreported cases were linked epidemiologically to measles cases reported to the LACDHS. Identifying co-symptomatic or secondary cases of measles in households of reported measles cases is the responsibility of the local health department. Although most measles cases are investigated within 2 weeks of disease onset, surveillance for disease among contacts of measles cases should be maintained for 15 days after the date of exposure. Disease investigators must be diligent in maintaining this measles surveillance to eliminate chains of transmission and characterize disease occurrence more accurately through identification of secondary measles cases. This surveillance may be the only effective way to identify children with measles who do not seek a medical provider, a combined 14 percent of the cases in the surveys.

In the past, Expanded Programme on Immunization-style cluster surveys have been used to determine disease incidence in developing countries (11), but we believe this is the first time such a community survey has been used to evaluate disease reporting. While this approach to evaluating measles

reporting has several advantages, such as affordability and the ability to evaluate all types of reporters, there are also limitations. Limitations include dependence on nonmedically trained persons for case descriptions, inability to identify measles cases which respondents do not report to interviewers, lack of laboratory confirmation for most probable cases identified, and small numbers for analysis.

Perhaps the greatest of these limitations to the evaluation of measles reporting is the dependence on family members for case descriptions. It was not possible to determine how parental recall affected the sensitivity of the measles case definition since some children did not visit physicians during their illnesses, the medical records of some children who sought physician care were not available, and several children who sought care apparently did so during the prodromal period.

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